CHAPTER ONE

Why Mathematics?

MATHEMATICS under the Nazi regime in Germany? This seems at first glance a matter of no real interest. What could the abstract language of science have to say to the ideology that oppressed Germany and pillaged Europe for twelve long years? At most, perhaps, unseemly (or seemly) anecdotes about who behaved badly (or well) might be offered. While such biographical material, when properly evaluated to sift out gossip and rumor, is of interest—history is made by human beings, and their actions affect others and signify attitudes—there is much more to mathematics and how it was affected under Nazi rule. Indeed, there are several areas of interaction between promulgated Nazi attitudes and the life and work of mathematicians. Thus this book is an attempt at a particular investigation of the relationships between so-called pure (natural) science and the extra-scientific culture. That there should be strong cultural connections between the technological applications of pure science (including herein the social applications of biological theory) and various aspects of the Industrial Revolution is obvious. Social Darwinism, and similar influences of science on social thought and action, have been frequently studied. It is not at all clear at the outset, however, that theoretical science and the contemporary cultural ambience have much to do with one another. Belief in this nonconnection is strengthened by the image of science proceeding *in vacuo*, so to speak, according to its own stringent rules of logic: the scientific method. In the past thirty years, however, this naive assumption of the autonomy of scientific development has begun to be critically examined.[1]

A general investigation of this topic is impossible, even if the conclusion were indeed the total divorce of theoretical science from other aspects of culture. Hence the proposal to study one particular microcosm: the relationship between mathematics and the intensity of the Nazi *Weltanschauung* (or "worldview") in Germany. Although 1939 is a convenient dividing line in the history of Hitler's Reich, nonetheless the prewar Nazi period must also be viewed as a culmination; the Germany of those years was prepared during the Weimar Republic, and both the cultural and scientific problems that will concern us have their origins at the turn of the century. World War I symbolized the conclusion of an era whose end had already come. Similarly, World War II was a continuation of what had gone before, and a terminal date of 1939 is even more artificial and will not be adhered to.

[1] One of the earliest examples is Paul Forman, "Weimar Culture, Causality, and Quantum Theory, 1918–1927," *Historical Studies in the Physical Sciences* 3 (1971): 1–16; and by the same author, "Scientific Internationalism and the Weimar Physicists: The Ideology and Its Manipulation in Germany after World War I," *Isis* 64 (1973): 150–180.

The concentration on mathematics may perhaps need some justification. At first glance, a straw man has been set up—after all, what could be more culture-free than mathematics, with its strict logic, its axiomatic procedures, and its guarantee that a true theorem is forever true. Disputes might arise about the validity of a theorem in certain situations: whether all the hypotheses had been explicitly stated; whether in fact the logical chain purporting to lead to a certain conclusion did in fact do so; and similar technical matters; but the notion of mathematical truth is often taken as synonymous with eternal truth. Nor is this only a contemporary notion, as the well-known apocryphal incident involving Euler and Diderot at the court of Catherine the Great, or the Platonic attitude toward mathematics, indicate.[2] Furthermore, there is the "unreasonable effectiveness" of mathematics in its application to the physical and social scientific world. Even so-called applied mathematics, concerning which Carl Runge[3] remarked that it was merely pure mathematics applied to astronomy, physics, chemistry, biology, and the like, proceeds by abstracting what is hypothesized as essential in a problem, solving a corresponding mathematical problem, and reinterpreting the mathematical results in an "applied" fashion.[4]

Mathematics also has a notion of strict causality: if *A*, then *B*. It is true that the standards of rigor, the logical criteria used to determine whether or not a proof is valid, that is, to determine whether or not *B* truly follows from *A*, have changed over time; nevertheless, the notion that it is conceivable that *B* can be shown always to follow from *A* is central to mathematics. As the prominent American mathematician E. H. Moore remarked, "Sufficient unto the day is the rigor thereof."[5] Both the necessary process of abstraction and the idea of mathematical causality separate mathematics from more mundane areas. Somewhat paradoxically, perhaps, they are also partly responsible for the great power of mathematics in application. Mathematical abstraction and mathematical causality seem to elevate mathematics above the sphere of the larger culture.

[2] Diderot is supposed to have challenged Euler to prove the existence of God, and Euler to have replied, "Monsieur! $(a + b^n)/n$, donc Dieu existe; répondez!" The mathematical expression attributed to Euler is, of course, nonsense. For the mythical aspect of the story, see R. J. Gillings, "The So-Called Euler-Diderot Incident," *American Mathematical Monthly* (1954): 77–80.

[3] Carl Runge was a professor at Göttingen, and a leading "applied mathematician" of the first part of the century. The remark is attributed to Runge by Heinrich Tietze in *Famous Problems of Mathematics* (New York: Graylock, 1963).

[4] For a discussion of the role of mathematics in application, see Eugene P. Wigner, "The Unreasonable Effectiveness of Mathematics in the Natural Sciences," *Communications in Pure and Applied Mathematics* 13 (1960): 1–14. Wigner writes: "The mathematical formulation of the physicists' often crude experience leads in an uncanny number of cases to an amazingly accurate description of a large class of phenomena. This shows . . . that it is in a very real sense the correct language . . . , fundamentally, we do not know why our theories work so well, hence their accuracy may not prove their truth and consistency. . . . The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve. We should be grateful for it" (pp. 8, 14).

[5] Quoted by Marvin Minsky in a lecture on computer science given at the annual meeting of the American Mathematical Society in New Orleans, Louisiana, 1965; also cited by E. T. Bell, *The Development of Mathematics* (1940), 503.

Twin popular illusions incorrectly elaborate upon this view and make mathematics seem even more remote from the general culture. The first of these is that the doing of mathematics is only a matter of calculation, or, more sophisticatedly, of logical step-by-step progress from one eternal truth to another via intermediate truths. This view is enhanced by the way mathematicians publicly present the results of their investigations: exactly as such logical progressions. In fact, however, the discovery of mathematics, as opposed to the presentation of it, is more like the reconnoitering of some unknown land. Various probes in various directions each contribute to the forming of a network of logical connections, often even unconsciously.[6] The realization of this network, the a posteriori checking for logical flaws, and the orderly presentation of the results, do not reflect the process of mathematical creativity, whatever that may be, and however ill it is understood.

The second illusion is that all that counts for a mathematician is to distinguish the correct from the incorrect. Correctness is indeed the sine qua non of mathematics, but aesthetic considerations are of great importance.

Among the various aesthetic factors influencing mathematical activity are economy of presentation, and the logic (inevitability) of often unexpected conclusions. While correctness is indeed *the* mathematical essential, some correct proofs are preferable to others. Proofs should be as clear and transparent as possible (to those cognizant of the prerequisite knowledge). A good notation, a good arrangement of the steps in a proof, are essential, not only to aid the desired clarity, but also because, by indicating fundamentals in the problem area, they actually incline toward new results. Clarity, arrangement, and logical progression of thought leading to an unexpected conclusion are well illustrated in an incident concerning no less a personage than the philosopher Thomas Hobbes:[7]

> He was 40 yeares old before he looked on Geometry; which happened accidentally. Being in a Gentleman's Library, Euclid's Elements lay open, and 'twas the 47 *El. libri* I.[8] He read the Proposition. By G——, sayd he (he would now and then sweare an emphaticall Oath by way of emphasis) *this is impossible*! So he reads the Demonstration of it, which referred him back to such a Proposition; which proposition he read. That referred him back to another, which he also read. *Et sic deinceps* [and so on] that at last he was demonstratively convinced of that truth. This made him in love with Geometry.

[6] Several personal examples can be found in J. E. Littlewood, *A Mathematician's Miscellany* (1953); reissued by Cambridge University Press (Cambridge, 1986), with other added material by Littlewood and a foreword (ed. Béla Bollobás) as *Littlewood's Miscellany*. See also Jacques Hadamard, *The Psychology of Invention in the Mathematical Field* (1949).

[7] John Aubrey, *Brief Lives*, Thomas Hobbes. The citation is from the edition by Oliver Lawson Dick, *Aubrey's Brief Lives* (London: Secker and Warburg, 1950), 150. Hobbes and Aubrey (who was nearly forty years younger) were friends, and Aubrey's "life" of the philosopher is the most extensive of those he wrote. For the friendship, see Dick, ibid.: xc–xci.

[8] The "Pythagorean Theorem."

A simple example of an "unbeautiful truth" is a list of positive integers. Mathematics is not frozen in time like a Grecian urn; solutions of old problems lead to new considerations. Though truth may not necessarily be beauty, beauty is truth, and for the mathematician impels to its own communications. As Helmut Hasse (who will be met again) remarks:[9]

> Sometimes it happens in physics again and again, that after the discovery of a new phenomenon, a theory fitted out with all the criteria of beauty must be replaced by a quite ugly one. Luckily, in most cases, the course of further development indeed reveals that this ugly theory was only provisional. . . .
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> In mathematics this idea leads in many instances to the truth. One has an unsolved problem, and, at first, has no insight at all how the solution should go, even less, how one might find it. Then the thought comes to describe for oneself what the sought-for truth must look like were it beautiful. And see, first examples show that it really seems to look that way, and then one is successful in confirming the correctness of what was envisaged by a general proof. . . . In general we find a [mathematical] formulation all the more beautiful, the clearer, more lucid, and more precise it is.

As Hasse puts it elsewhere, truth is necessary, but not sufficient for real (*echt*) mathematics—what is also needed is beautiful form and organic harmony.

One result of this aesthetic is that the mathematician thinks of himself as an artist, as G. H. Hardy did:[10]

> The case for my life, then, or that of anyone else who has been a mathematician in the same sense in which I have been one, is this: that I have added something to knowledge, and helped others to add more; and that these somethings have a value which differs in degree only, and not in kind, from that of the creations of the great mathematicians, or of any of the other artists, great or small, who have left some kind of memorial behind them.

Or, as Hasse says even more forcefully, "The true mathematician who has found something beautiful, senses in it the irresistible pressure to communicate his discovery to others."[11]

Mathematics is the "basic science" sine qua non. At the same time, it is quite different from basic experimental science by being divorced from laboratory procedures. Even so-called applied mathematics only takes place on paper with pencil.[12] The hallmark of mathematics is logical rigor. However important or

[9] Hasse, *Mathematik als Wissenschaft, Kunst, und Macht* (1952), 18–20. Hasse also makes many analogies between mathematics and music in particular. This theme is also discussed in R. C. Archibald, "Mathematicians and Music," *American Mathematics Monthly* 31 (1924): 1–25. See also note 16 below.

[10] G. H. Hardy, *A Mathematician's Apology* (Cambridge: Cambridge University Press, 1969), 151 (original edition, 1940).

[11] Hasse 1952: 26.

[12] A laboratory may provide the idea for a piece of mathematics, but the actual doing of the mathematics is not with machinery. Computing machines are generally used to provide suggestive "experiments," a posteriori verifications, supplementary data extending a proof to a previously untreated finite range, or counterexamples by extensive numerical search. Recent "computer proofs" in mathematics, such as of the famous "four-color problem," or the existence of a projective plane of

suggestive or helpful heuristic or analogical arguments may be, it is only the mathematical proof according to accepted standards of logical rigor that establishes a mathematical result. Those logical standards may be and are disputed (and were in Nazi Germany), but given an accepted set of such standards, mathematical proofs according to them establish mathematical results that are true without qualification. On the one hand, a mathematical result is "sure"; on the other, however, all but the final results with proofs are, at best, incomplete mathematics: the mathematician's "experiments" are usually eminently unpublishable as such. This removal of mathematics from the concrete world contributes to the mathematical aesthetic. While there are notions of a "beautiful" experiment in the experimental sciences, in mathematics the aesthetic is purer for its removal from the natural irregularities of concrete life. "As for music, it is audible mathematics," writes the biologist Bentley Glass,[13] and perhaps the traditional[14] musical aesthetic is the one most closely resembling the mathematical; here, too, given the underlying assumptions, there is a purity of form that is part of the notion of beautiful. Deviations like Mozart's *Musikalischer Spass* or some of the less slapstick efforts of P.D.Q. Bach (Peter Schickele) are jokes because of their introduction of irregularities into a presumed form. Similarly, Littlewood presents as humorous an unnecessarily cumbrous presentation of a proof that can be expressed quite clearly and elegantly.[15] The papers of Hasse and Archibald cited earlier also stress the analogy between the musical and the mathematical aesthetic.[16]

In some sense, then, mathematics is an ideal subject matter; it is, however, made real by the actions of mathematicians. In Russell's well-known words:[17]

> Mathematics possesses not only truth, but supreme beauty—a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, sublimely pure, and capable of a stern perfection such as only the greatest art can show.

Nevertheless, mathematicians make tremendous emotional investments in the doing of mathematics. Mathematicians, despite their pure aesthetic, the divorce of their actual work from concrete reality, and the surety of their results, are not like petty gods in ivory towers playing at abstruse and difficult, but meaning-

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order 10, do not alter this statement. In such problems, many sets of cases (to which mathematical theory had reduced the problem) needed to be verified, the number being well beyond human capacity. The theory of computing and computing machines, including the design of algorithms, is, in contrast, part of mathematics. The division into "pure" and "applied" mathematics, or into "theoretical" and "experimental" in physics, is a comparatively recent phenomenon.

13 Bentley Glass, "Liberal Education in a Scientific Age," in Paul Obler and Herman Estrin, eds., *The New Scientist: Essays on the Methods and Values of Modern Science* (1962), 215–238, 233.

14 Aleatoric music and computer-generated music are not considered in this sentence. On the other hand, systems like Schönberg's *Tonreihe* quite clearly are.

15 Littlewood 1986: 49–52.

16 However, the widespread belief in the frequent conjunction of mathematical and musical *ability* seems at best a dubious proposition. See G. Revesz, "Die Beziehung zwischen mathematischer und musikalischer Begabung," *Schweizerische Zeitschrift für Psychologie, und Ihre Anwendungen* 5 (1946): 269–281.

17 Bertrand Russell, "The Study of Mathematics," *New Quarterly* (Nov. 1907), reprinted in Bertrand Russell, *Philosophical Essays* (London: Longmans Green, 1910), 71–86, quote from p. 73.

less, games. The final piece of mathematics is abstract, aesthetically beautiful, and certain; but it is not (nor could it be) an instantaneous or automatic creation. The *doing* of mathematics is as emotionally involved, often clumsy, and uncertain as any other work that has not been reduced to a purely automatic procedure.[18]

Thus, the nature of mathematical abstraction and mathematical causality, coupled with the popular ignorance of the nature of mathematical research and the removal of mathematics from the everyday world, seem to make mathematics one of the least likely subjects for the sort of investigation proposed. Yet some Nazi mathematicians and psychologists stood this reasoning on its head. At the same time, they emphasized with a peculiarly Nazi bias the often neglected roles of aesthetics and inspiration in creating mathematics. They argued that exactly the apparent culture-free nature of mathematical abstraction and mathematical causality makes mathematics the ideal testing-ground for theories about racially determined differences in intellectual attitudes. As E. R. Jaensch wrote in 1939:[19]

> Mathematics can simply have no other origin than rational thinking and mental activity (*Verstandestätigkeit*). "Irrational" mathematics would be a wooden iron, a self-contradiction. If, therefore, one discovers something worth exposure about the ways of thought (*Verstandeskräfte*) that still command the field on this area—and that happens in many respects with complete justice—so one can hereby only obtain help by bringing other forms of rational thought in more strongly—in no case however, through the conjuring up of irrationality. This way is simply excluded in mathematical thought. Even if in other scientific and educational disciplines it is possible artificially still to maintain the appearance that Reason (*Verstand*), as treated through that radical cure, still lives—in Mathematics it is impossible.
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> Hereby, the question of mathematical thought attains the character of an especially instructive example—an "illuminating case" in Baco's [sic] sense—for the forms of logical thought and rationalism above all, but also in other areas of knowledge and in everyday life.

What is important to note here is the insistence that the supposed autonomy of mathematics from irrational influence makes it exactly appropriate for investigating various intellectual types. Just because of the rationality of its results, mathematics was deemed an excellent medium for perceiving the various important differences between different peoples' ways of thought. It did not prove difficult to discover, for example, a Nordic type, a Romance or Latin type, a Jewish type, and, in fact, several subvarieties of these. Jaensch's theory of types could be elaborated independent of or in conjunction with *Rassenseelenkunde*, or the theory of the "racial soul." This was done most prominently by the distinguished mathematician Ludwig Bieberbach, who will be discussed particularly in chapters 6 and 7. By delineating a "Nordic" mathematics distinct from

[18] Indeed, when automatic procedures or algorithms are well known in mathematics, they are simply cited.

[19] E. R. Jaensch and F. Althoff, *Mathematisches Denken und Seelenform* (1939), vii–ix.

French or Jewish mathematics, great emphasis could be placed (necessarily) on the mode of intellectual discovery as opposed to its fruits, and, therefore, on feeling and attitude toward the world.

However important this inversion of the usual attitude toward mathematics may be for investigation, there are at least two other reasons arguing for a study of mathematics in the Nazi period. The first is that among the substantial number of mathematicians who were sympathetic in varying degrees to the Nazi cause were several who attempted to associate the political argument with various philosophical differences within mathematics. This did not alter the truth of any mathematical fact, but it did declare that certain mathematical disciplines were "more equal" than other varieties. Nor was this simply a question of "pure" versus "applied," of theory versus immediately usable results. Both these beliefs and the ones about the salience of psycho-racial differences within mathematics also argued for the distinction in differences of pedagogical style. Put succinctly, a Nazi argument promoted by Bieberbach was that because Jews thought differently, and were "suited" to do mathematics in a different fashion, they could not be proper instructors of non-Jews. Indeed, their presence in the classroom caused a perversion of instruction. Thus an elaborate intellectual rationale for the dismissal of Jews was established, discussed, and defended.

In addition to these psychological, philosophical, and pedagogical arguments that, however seemingly perverse today, reveal that mathematics, at least in its "doing," if not perhaps in its "being," may be less culture-free than one thinks at first, there is yet another facet of mathematics in the Nazi period that deserves investigation. With the advent of Hitler, irrationalist themes in German thinking achieved political respectability—indeed, became the order of the day. Thus the historian Walter Frank could say:[20]

> Let us clearly understand one another, the intellectual is the exact opposite of the spiritually creative (*geistig Schaffenden*). The creator produces values. The intellectual defines the values produced by others. The intellectual is the clever man, the educated one, but also the one without character or personality. The greatest enemy of the creator (*Schöpfers*) is not the primitive man. For his instinct can now and then more easily comprehend great things than all the cleverness of the clever. The greatest enemy of creativity (*Schöpfung*) is always the clever man.

Similarly, Otto Dietrich in 1935 could remark:[21]

> National Socialism does not tend to dry abstract thinking. Its *Weltanschauung*, tied to the *Volk*, will open up once more learning (*Wissenschaft*) to flowing Life, and the infinite fullness of life to learning.

[20] Walter Frank, *Kämpfende Wissenschaft* (Hamburg: Hanseatische Verlagsanstalt, 1934), 30, as cited by Leon Poliakov and Josef Wulf, *Das Dritte Reich und Seine Denker* (1959), 51.

[21] Otto Dietrich was Hitler's press chief, latterly turned philosopher. The citation is from *Die philosophischen Grundlagen des Nationalsozialismus* (Breslau: Ferdinand Hirt, 1935), 38, as cited by Poliakov and Wulf 1959: 278. According to Poliakov and Wulf (276), Alfred Rosenberg complained about Dietrich and his ilk: "Where were the new philosophers ten and fifteen years ago?"

And Edgar von Schmidt-Pauli in 1932,[22] explaining the attraction as he saw it of the party he believed in:

> National Socialism corresponded to the spiritual (*seelischen*) position of the broadest layers of the German people, which, in the garden of errors [*Irrgarten*, usually translated "maze"] of the rationalism of the postwar years, yearned instinctively for powerful leadership.

In such an atmosphere, it was reasonable to fear that the common view of mathematics as the rational subject sine qua non might jeopardize its public standing, its role in the schools, the state funds it received. Not only irrationalists attacked mathematics in the Nazi period, but also some "rational" physicists of Nazi persuasion. Thus one finds Nazi sympathizers among mathematicians defending mathematics from the attitudes of some of their political brothers-in-arms, like Phillip Lenard. Lenard, a Nobel laureate physicist and early supporter of Hitler, argued in his *Deutsche Physik* (1936) that it was important for students to avoid studying too much mathematics in school! In his view, mathematics was the "most subordinate intellectual discipline" because, under Jewish influence, it had lost its "feeling for natural scientific research."[23]

Even conceding to these varied Nazi thinkers that the supposed autonomy of mathematics from the rest of culture is precisely what makes it the ideal medium for investigating the factual content of other a priori truths, it does not necessarily follow that an investigation of the sort proposed is called for. It is all too tempting to look back on the Nazi period in Germany and dismiss all the consequences of its point of view as detestable and patent falsehoods when considered rationally. The terrors of the Nazi regime make it even easier to reject all aspects of Nazi thought as self-serving propaganda, and any possible relationships to mathematics or mathematicians the result of compulsion or time-serving. Such a point of view overlooks the fact that the Nazi philosophy was an all-embracing worldview with its full complement of intellectual theorizing. The Nazi emphasis on rearmament would necessarily lead to an emphasis on the military uses of science, and a concomitant disparagement of science, whose immediate applications were not easily seen, might be expected. This point is only enhanced by a remark of Hans Heilbronn, "The application of mathematics to military problems was neglected in Hitler's Germany, certainly by comparison with England and the U.S. And in some cases the armament industry in the widest possible sense provided a refuge for anti-Nazi mathematicians who had been expelled from the universities, and could not emigrate."[24]

[22] Edgar von Schmidt-Pauli, *Die Männer um Hitler* (Berlin: Verlag für Kulturpolitik, 1932), 27.

[23] Philip Lenard, *Deutsche Physik* (1936), 1:6.

[24] Heilbronn, in a personal letter to Jonathan Liebenau (Oct. 10, 1974) in my possession. Similarly, Wilhelm Magnus (for whom there were no bars to a university position) told me of his own "retreat" into industrial work in 1936 in order to avoid the politics of the university (interview, 1982).) However, in 1940 Magnus became professor at the Technische Hochschule in Berlin, presumably to avoid the war industry. Perhaps the best-known case of such "industrial emigration" is Gustav Hertz. The nephew of Heinrich Hertz, his father was Jewish. Having shared the Nobel Prize

What is more interesting, as the journal *Deutsche Mathematik* (1936–1943) and articles by mathematicians of the stature of Ludwig Bieberbach and Wilhelm Blaschke make clear, is an attempt to distinguish within the mathematical community between mathematics that was "rooted in the national people" (*völkisch verwurzelt*) and that which was not. In other words, "Deutsche Mathematik" was not simply a question of expelling Jewish professors from the university or deemphasizing the roles of non-German nationalities in the creation of mathematics; it was the quite serious matter of discerning what was a typically "Nordic" mathematics suitable for and to the new German state and its aspirations. This task also involved the historical problem of finding common Nordic elements in the great German non-Jewish mathematicians from Kepler to Hilbert that could be shown as lacking among the Jews as well as the French.[25]

Given that something so seemingly value-free as mathematics can be imbued with ideological content, and that the Nazi period provides a prime example of such attempts, as well as the several different Nazi streams of thought affecting mathematics, it becomes interesting to see just what this "cultural conditioning" meant for mathematics, and what its effects were, if any. The positions taken up by propagandists for "Nordic Mathematics" cannot be dismissed as simple flattery of the powers regnant.[26] What, if anything, about Germany and mathematics provoked these German mathematicians to their opinions? Such problems have perhaps disturbing echoes today, when some academics talk about "the political structure of mathematics," when there is a confusion between the intrinsic nature of a discipline and the behavior of its practitioners toward outsiders, when some philosophers of science espouse a radical relativism that rejects all truth claims. Furthermore, as will be seen, reading the pedagogical concerns of German university mathematicians in the late 1920s and 1930s—concerns that antedated but were exacerbated by the Nazis—sometimes makes the similar concerns of some contemporary American mathematicians seem like "déjà vu all over again."

In addition, it is clear that the National Socialist typology cannot be dismissed out of hand as mere typology and so unworthy of further consideration. Psychological typology was popular in many circles between the wars, as well as earlier. A case in point is the American psychologist A. A. Roback, author of *The Psychology of Character* (1927) and many other works dealing with characterol-

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in physics with his countryman James Franck (who emigrated in 1933), he lost his professorship at Berlin in 1935. Between then and 1945, Hertz was a technical director for Siemens, from 1945 to 1954 was in the Soviet Union, in 1954 became a professor in Leipzig, and received the National Prize (First Class) of the DDR (East Germany) in the following year.

[25] The English, of course, were Aryans. Hitler at first saw them as a natural ally, and in the prewar years Maxwell and Newton were included in the pantheon of Aryan science. For example, B. Thüring, in *Deutsche Mathematik* 1 (1936): 10, writes of the "North-German feeling for Nature at the basis of Kepler's and Newton's work" in contrast to Einstein's. Newton is also characterized as a "German researcher" by Thüring.

[26] To be a Nazi party member and a scientist did not make it necessary to propagandize a Nazified science. The famous physicist Pascual Jordan became a member of the Nazi party in 1933, but opposed Ludwig Bieberbach's "Deutsche Mathematik" ideas; see below, chapter 7.

ogy (including a 1927 bibliography of over 3,200 items). A story in *Time* magazine in 1935 reported on his attempts to distinguish Jewish students (positively in this case) by their writing style.[27] Roback clearly did not realize that his methodology, rather than the use others made of similar observations, might be at fault. Indeed, his report shows his obvious pro-Jewish bias. Ironically, the students examined by Roback were in a class taught by his colleague Gordon Allport (the future author in 1954 of *The Nature of Prejudice*). It is interesting that an anti-assimilationist Jewish researcher and scholar could be dedicated to typology that distinguished a Jewish type (defended by simplistic and erroneous statistics) as a mode of investigation without considering it insidious as late as 1935. *Time* certainly thought so.

From a methodological point of view, history that does not deal in biography must necessarily conceive of varieties of abstract individuals as its enactors. However much one talks about forces and movements, nevertheless, whatever motivates history, it is *made* by people.[28] It is nearly banal to observe that categories of individuals are constructed by abstraction of commonly held views; that a complex of views is associated with a category; and that no single individual placed in that category necessarily holds all the views associated with it, though such a person will presumably hold the defining ones. In addition to such attitudinal categories, there are all the natural categories of profession, nationality, socioeconomic status, race, religion, and so forth, into which people place themselves during their lives. If groups of people have a common heritage, or common activity, or common upbringing, one tends to look for other aspects of that commonality that may not be visible superficially. This makes it necessary and valid to sometimes speak of Germans, of scientists, and, as a subgroup of the latter, of mathematicians. It is not the intention to speak of a fixed national character. Henry V. Dicks, in a preliminary psychological study of Nazi ideology, remarks:[29]

> When speaking of "national character" we mean only the broad frequently recurring regularities of certain prominent behaviour traits and motivations of a given ethnic or cultural group. We do not assert that such traits are found in equal degree, or at all, in all members of that group, or that they are so conjoined that the extreme is also the norm. Neither do we assert that the traits are found singly or in combination in that group alone.

[27] *Time* magazine (Sept. 30, 1935): 35. Roback's original report is in *Character and Personality* 4 (1935–36): 53–60.

[28] So, for example, Eugen Weber remarks in an article on Romanian fascism: "All of which suggests that the major factors in a radical or revolutionary orientation are less strictly sociological than psychological: those cultural and, above all, chronological factors which make for greater availability, greater restlessness, greater receptivity, at least, to possibilities of change and of action to secure change." "The Men of the Archangel," *Journal of Contemporary History* 1 (1966): 101–126, p. 120.

[29] Dicks, "Personality Traits and National Socialist Ideology," *Human Relations* 3 (1950): 112. See also by the same author *Licensed Mass Murder* (Heinemann: Sussex University Press, and London: Educational Books, 1972).

Are there sociopsychological factors linking the professional activity of certain mathematicians, among them very fine ones, and their adherence to the National Socialist cause? Given the tremendous force and ubiquity of the Nazi *Weltanschauung*, there is the additional aspect of the potential relationship, if any, between the general forms and interests of mathematical scholarship during the Nazi period and this worldview. Indeed, one highly respected strain of the German intellectual tradition "conceived universal history as the progressive differentiation of the peculiar character of each nation."[30] When, under the Nazis, that "peculiar character" became the highest of values, the pressures for it to pervade all intellectual activity were monstrously increased.

One relevant question thus may be: how do mathematicians think? This question seems particularly interesting, since mathematicians are viewed by the lay public as an esoteric lot, the Brahmins of a largely unintelligible science. The curiosity about inhabitants of this purported *sanctum sanctorum* of mathematics is reflected popularly in such items as a rather negative article in *New Yorker* magazine replete with unsubstantiated assertions,[31] or the pejorative and banal view of the mathematician as a disembodied intellect who is "not of this world" until stirred to enter it. A far less trivial example within German culture of the mathematician as disembodied intellect, but construed positively this time, is in Robert Musil's monumental *The Man without Qualities*.[32] Here it is exactly the disembodiment that permits a dispassionate view of society. In any case, one way the question can be put is: how real is this disembodiment?

Musil, at one point in his career, was an applied mathematician; the cited pamphlet by Hasse, as well as books by mathematicians such as Henri Poincaré, G. H. Hardy, and Jacques Hadamard, attest to the mathematicians' own interest in "what makes a mathematician," and "how mathematicians think." Hadamard's book in particular, while addressing itself to the general problem of creativity, treats it by soliciting mathematicians' own introspective opinions of how they think.[33] Nevertheless, his book is not very illuminating on this issue, except to emphasize that mathematical thought does not take place like the step-by-step procedures of an automaton, that many mathematicians often think initially in vague images rather than in symbols, and that the thought processes are not clear to the mathematician doing the thinking. Many mathematicians have testified to this only vague knowledge of their thinking processes. Yet, one striking fact is that the *results*, when successful, are remembered until they can be written down *in extenso* with the usual mathematical formul-

[30] Hans Kohn, "Rethinking Recent German History," in idem, ed., *German History: Some New German Views* (London: Allen and Unwin, 1954), 29, in discussing Ranke.

[31] Alfred Adler, "Reflections: Mathematics and Creativity," *New Yorker* (Feb. 19, 1972): 39–45.

[32] Robert Musil, *The Man without Qualities*, trans. E. Wilkins and E. Kaiser (New York: Coward-McCann, 1953–60), orig. ed. *Der Mann Ohne Eigenschaften*, published posthumously (Hamburg: Rowohlt, 1952). Musil was an Austrian, and the novel is about Vienna, but it seems fair to adduce it as a representative of German (-speaking) culture.

[33] Hadamard 1949: 2.

ary, and that the occasion of the insightful event can be recalled after many years.

Thomas Kuhn's words;[34] "I hope to have made meaningful the view that the productive scientist must be a traditionalist who enjoys playing intricate games by pre-established rules in order to be a successful innovator who discovers new rules and new pieces with which to play them," would seem to apply with special force to mathematicians. Almost as an afterthought, Kuhn adds the caveat that perhaps what he has been saying only applied to "basic science," and[35] "the personality requisites of the pure scientist and of the inventor may be quite different with those of the applied scientist lying somewhat between."

Mathematicians as practitioners of "basic science" certainly use the metaphors of play as well as aesthetic ones in describing their work. Even if how mathematical innovation is accomplished is no clearer to mathematicians than to others, the occasion of that innovation is clearly remembered despite the vagueness of the intellectual processes. For one example, J. E. Littlewood writes (forty years after the event) of a famous result of his:[36]

> The problem seethed violently in my mind . . . and the "idea" was vague and elusive. Finally I stopped, in the rain, gazing blankly for minutes on end over a little bridge into a stream (near Kenwith Wood) and presently a flooding certainty came into my mind that the thing was done. The 40 minutes before I got back and could verify were none the less tense.

It seems, therefore, that attempts at delineating specific separate compartments in a mathematician's mind are hopeless.

Nevertheless, no discipline is ever entirely separate from its practitioners. Although mathematics was not an obvious academic "pressure point" for the Nazis, as disciplines as varied as biology, anthropology, history, German literature, and architecture were, a large number of prominent mathematicians were at least Nazi "fellow-travelers," or even open propagandists for the Nazi cause.

In an unpublished paper,[37] Thomas Reissinger has raised the question, "How is it that mathematicians [as a group] did not see through [the Nazi ideology and practice] at least a little bit better than their nonmathematically trained fellow men?" Though mathematicians are, as a group, as human and fallible as others when it comes to cultural, political, or ideological matters, this question does, nevertheless, have meaning. Reissinger draws an answer from Karl Popper's philosophy of science. In the physical sciences, observes Reissinger, one seeks "general laws," which then serve to explain particular occurrences by examination of "boundary conditions." In mathematics, the emphasis on general laws (perhaps subject to side conditions) is even more intense. The mathemati-

[34] Thomas S. Kuhn, *The Essential Tension* (1977), 237. This is a collection of essays. The cited essay is "The Essential Tension: Tradition and Innovation in Scientific Research," 225–239.

[35] Ibid.: 238–239.

[36] Littlewood 1986: 83.

[37] Thomas Reissinger, "Die Verführbarkeit der Mathematiker" (The seducibility of mathematicians), University of Mannheim, preprint no. 120 (n.d.).

cian, above all, seeks to prove conjectures through a deductive chain of reasoning, and logical and analytical training is directed to that end. History, on the other hand, is concerned with singular events, and concentrates on nontrivial boundary conditions. Thus, mathematical training, however it prepares the faculties for analysis, is not only of no aid in judging historical/political situations, it perhaps inclines toward misjudgment. Furthermore, intellect has no necessary connection with the ability to reason. This, certainly, is banal, but Reissinger argues further that the ability to reason about ideas depends upon free exchange with others leading to critical examination. The solipsistic aspect of mathematical training and practice does not, however, favor such uses of reason.

The reader may or may not agree with these ideas of Reissinger. What is interesting about them is their explanation of a lability of many mathematicians, opening them to uncritical acceptance of political slogans and ideological posturing, while eschewing any historicist notion of hidden social forces upon which historical events are merely epiphenomena. This is not to deny that, as in every discipline, one finds every sort of reaction to the Nazis among German mathematicians. Nor is it to deny that the majority of German mathematicians who remained in Germany were not active Nazi sympathizers, but simply attempted to do their best to uphold their discipline in a difficult time. But there were also many mathematicians, both young and old, who were opportunists and took advantage, either of necessity or shamelessly, of the situation, either to attack and destroy opponents, or just to advance themselves. Among mathematicians there were, as already mentioned, *völkisch* ideologists, as well as conservative nationalists who were too “unpolitical” to understand the difference between the Third Reich and a conservative or even monarchist government. There were prominent mathematicians who partook in the mystical appreciation of Hitler as German savior, and those who wrote letters of denunciation. All these many varied types deserve consideration because, beyond providing the trite proof that mathematicians are as human as anyone else, they reflect the state of mathematical activity at the time.

The first quarter of the twentieth century saw both Germany and mathematical science (in which Germans were prominent) confronted with multiple crises: in the former case, political and psychological; in the latter, technical and psychological. Simply to make some sort of equation here and so pass matters off is too pat and comfortable to be true; however, the nature of these crises and the temperaments engendering and confronting them deserve further examination.